QUANTITATIVE METRICS FOR HEDGE FUND PERFORMANCE EVALUATION:

A PRACTITIONER'S GUIDE

By

Darsh Singh

A thesis submitted to John Hopkins University in conformity with the requirements for the degree of Masters of Science in Engineering in Financial Mathematics

Baltimore, Maryland
December 2014

Abstract: In the past two decades, the number of hedge funds and the amount of assets being managed by hedge funds have skyrocketed in lockstep with increased allocations to hedge funds from institutional investors across the globe. This paper discusses the importance of manager selection in the hedge fund allocation process. It then touches on the development of the Capital Asset Pricing Model, a pivotal time in the history of fund performance measurement. Finally, it explores how a portfolio manager uses quantitative metrics in practice to evaluate potential hedge fund investment opportunities illustrated with an example of manager selection by an existing institutional investment portfolio manager.

Advisors: Dr. Daniel Naiman, Dr. David Audley

Keywords: hedge fund, alternatives, investments, investment strategy, investment performance, Capital Asset Pricing Model (CAPM), Sharpe, capital allocation, manager selection, GIPS

Preface

Armed with a degree in engineering science from Trinity University, I moved to Fort Meade to serve in US Intelligence. The opportunity to work in the intelligence community satisfied a hunger to gain a deeper understanding of how the world works and, more importantly, global and systemic risks. The training I received from the Department of Defense sharpened my mind on risk monitoring and risk management. Once the financial crises of 2008 hit the markets, Foundations and other investment managers beckoned me to apply my risk management tools and techniques to their investment portfolios. I quickly became a student of the markets and began to study the intimate link between risk and reward in investments around the globe.

As I dove deep into the vast array of investment opportunities, I became fascinated with the world of hedge funds. Their existence represented a form of capitalism that both excited and frightened me – a world that contained tremendous reward and the ability to financially bankrupt an investor, all wrapped into an asset class. The topic of this thesis came from my desire to better understand the academic theory and share how I have applied it in the real world.

I would like to thank Dr. Daniel Naiman and Dr. David Audley for their patient encouragement and persistence in supporting me through multiple iterations and industry-laden jargon. In addition, I would like to thank the team at Satori Capital for supporting me and minding the shop while I focused on writing, especially Randy, Sunny, and James

for their trust in me. Lastly, I'd like to thank my parents, siblings, and lovely wife for their everlasting support and love in all of my endeavors.

Table of Contents

List of Figures

Introduction and Description of Hedge Funds

In 1997, BarclayHedge reported that the total assets managed by hedge funds were just over $100 billion. At the end of Q3, 2013, the report estimated that the hedge fund industry was managing over $2 trillion; in the last 16 years, the industry has grown by over 20 times.[1] Additionally, the Boston Consulting Group believes that by 2015, over $3.3 trillion dollars will be allocated to hedge funds. As the growth of the industry continues, many institutional investors are exploring different frameworks for allocating capital to hedge funds. This paper explores a history of quantitative measures frequently used to evaluate hedge fund performance, current industry performance measurement standards, and a case study on how a portfolio manager at Satori Capital applies these techniques to manager selection.

A. What are hedge funds?

At the simplest level, hedge funds are investment vehicles that invest in wide range of financial instruments. This type of investment vehicle is managed or administered by a professional management firm that the capital providers believe has the ability to generate desirable investment returns. Typically, the management firm members invest a significant amount of their wealth in the vehicle alongside investors to demonstrate an alignment of interests. Historically, market regulations limited the availability of hedge fund investments to just sophisticated and accredited investors. Because of this regulatory

[1] "Hedge Fund Industry Assets Under Management." BarclayHedge, n.d. Web. 15 Aug. 2014. <http://www.barclayhedge.com/research/indices/ghs/mum/HF_Money_Under_Management.html>.

oversight, hedge funds have, and continue to receive, much more flexibility in the investment strategies they employ relative to traditional investment strategies.

The economic function of hedge funds is to provide an array of investment options that seek to generate great investment returns on behalf of its investors. Over time, the hedge fund industry has pioneered a wide range of investment strategies in the pursuit of desirable investment returns. Many wealthy individuals and institutional investors have reallocated capital to hedge funds because traditional investment strategies may not have fulfilled the reward or risk targets the investor was seeking to achieve.

B. What types of hedge fund strategies are there?

The long-short equity strategy is debatably the oldest hedge fund strategy. The strategy consists of building long and short exposures in a portfolio such that correlations to the broad market are hedged (hence the term "hedge fund"). Typically, these managers implement deep fundamental analysis and build their thesis using a "bottoms-up" approach. The underlying assumption is that the manager maintains an extraordinary stock-picking ability and will be able to generate desirable absolute returns. One of the most notable long-short equity managers is Julian Robertson, founder of the Tiger Global.[2]

A second strategy is the global macro approach, which can be viewed as "top-down" strategies. Managers use macroeconomic models and data to create broad investment

[2] Stefanini, Filippo. *Investment Strategies of Hedge Funds*. Chichester, England: Wiley, 2006. Print.

themes or theses. Many notable hedge fund managers use this approach, including George Soros and John Paulson. Event-driven strategies are characterized by an underlying thesis that value can be created or destroyed at the occurrence of a specific event, such as an acquisition, recapitalization, bankruptcy. The event-driven style has a large subset of popular strategies, including merger arbitrage, activist investing, distressed debt investing, and many more.[3] In recent years, Kyle Bass of Hayman Capital has become a prominent event-driven manager.

Lastly, there are relative value strategies, which are designed to profit from discrepancies in closely-linked securities. Typically, this strategy has little to no exposure to the movement of broad markets. Equity market neutral and credit long-short strategies are contained in this subset as well as a variety of arbitrage strategies including: fixed income, convertible, statistical, volatility and many more. One of the most famous hedge fund disasters involved a group called Long Term Capital Management, a team that included two Nobel Prize-winning economists and some of the most well-known people on Wall Street. This team implemented highly-levered arbitrage strategies across many markets and was very successful, until Russia defaulted on its debt in 1998 that sent shock waves across the market and put the all-star team out of business.[4][5]

While these are a few broad categories that capture a large set of hedge fund strategies, there are countless other strategies and methods of investing capital in pursuit of returns

[3] Ibid
[4] Ibid
[5] Lowenstein, Roger. When Genius Failed: The Rise and Fall of Long-Term Capital Management. New York: Random House, 2000. Print.

that have not been outlined here. As macroeconomic settings shift and market microstructures are integrated and disintegrated, new strategies continue to emerge. Having a set of tools to evaluate the performance of a hedge fund becomes increasingly important for capital allocators to objectively select the best investment managers in the industry.

Performance Dispersion Makes Manager Selection a Crucial Component of Hedge Fund Investing

In the table below, the Lipper TASS database of hedge fund performance (which includes funds that have been eliminated from the selected universe, thereby reducing survivorship bias) was examined by Pete Wilson and Jason Malinowski from 2002-2011 to study fund performance dispersion within each asset class.

Figure 1: Performance Dispersion by Asset Class (Wilson et. al 2012)

		Fixed income	Equity	Hedge funds
Percentiles	10%	9.5%	14.2%	23.5%
	25%	4.3%	6.3%	10.0%
	50%	0.0%	0.0%	0.0%
	75%	-3.3%	-5.4%	-8.2%
	90%	-6.1%	-10.4%	-16.3%
	Interdecile range	**15.6%**	**24.5%**	**39.8%**
	Interquartile range	**7.6%**	**11.7%**	**18.2%**

Compared to the traditional equity and fixed-income asset classes, hedge funds as an asset class experienced significantly higher dispersion in their investment performance. As noted in the table, the dispersion between the top and bottom quartile for all hedge

funds averaged 18.2%. Furthermore, once the hedge funds were categorized into Lipper-provided strategies and the dispersion versus the strategy medians was calculated, the dispersion decreased only slightly to 17.5% (a 4% reduction). In comparison, the authors also used the Morningstar database of mutual fund performance to examine how much dispersion could be attributed to strategy. When adjusted for strategy, dispersion fell to 3.6% for fixed income (a 52% reduction) and 7.4% (a 37% reduction) for equities.[6]

This result demonstrates that virtually all dispersion in hedge fund returns during the 10-year period was driven by manager-related risk, not investment strategy. While the vast majority of industry participants seek to categorize hedge funds by strategy (perhaps because it's easier to understand), it is a poor framework for exploiting data for meaningful data that might translate to actionable recommendations.

Why Quantitative Measures Are Useful for Practitioners

In practice, there are tens of thousands of hedge fund managers located across the world and hundreds are launched each year.[7] For any practitioner that wants to explore the marketplace, quantitative measures are a scalable solution to be able to quickly filter through data that can be found on Bloomberg, hedge fund databases available for purchase, or even social networking sites dedicated to hedge fund investing. In addition,

[6] Wilson, Pete, and Jason Malinowski. *Hedge Fund Breakthrough*. Publication no. July 2012. N.p.: Blackrock, 2012. Print.
[7] Citi Investor Services: Business Advisory, "The Rise of Liquid Alternatives". *Presentation to CAIA in Chicago*. May 21st 2014.

maintaining a wide range of measures that quantify risk and return – the two building blocks of investment analysis – allow for flexibility and focused methods of identifying hedge fund investments that have performed in line with very specific parameters. Allocators seeking to invest in hedge funds come with a wide variety of desires, ranging from reducing volatility and correlation to the broad market to leveraged bets on directional market exposure.

Risk and Return

As mentioned above, risk and return are the two building blocks of investment analysis and are measured using either absolute or relative measures. Absolute measures focus on standalone nominal returns while relative measures focus on returns relative to a certain benchmark. The debate of whether measuring investment performance relative to an index or on a standalone basis has been a long-standing one in the investment community. It is even more heated in the hedge fund industry because of the fee structures. For instance, when the hedge fund industry first started, most investors were focused on generating absolute returns. To create alignment around the focus on absolute returns, hedge funds would charge a 20% performance fee on all profits. This incentivized hedge fund managers to focus on generating profits in all market environments. While the industry may have initially been tasked with focusing on absolute returns, the past few decades have transformed it into one with a wide variety of mandates. Both absolute and relative measures can add value to the analysis and selection of fund manager.

The following section will highlight some of the most frequently used quantitative measures to assess the performance of an investment manager prior to the advent of the Markowitz' landmark paper published in 1952. The prevailing theme of these measurements are that they are measuring performance *ex post*. In the section after this, we will explore how Markowitz laid the groundwork for the Capital Asset Pricing Model (CAPM) which drastically improve the quantitative measures being used to evaluate investment performance.

A. Absolute Measures

Average Return (Arithmetic Mean): A simple average return that is calculated by summing the returns for each period and dividing the total by the number of periods. The simple average return does not consider the compounding effect of returns. Because it does not take into account the compounding effect, average returns are the best tool for calculating an expected return over short periods of time.

$$\text{Average Return} = \frac{\sum_{i=1}^{N} R_i}{N}$$

where N = number of periods and R_i is the return for period i.

Compound Monthly Return (Geometric): The monthly average return that assumes the same return every period that results in the equivalent compound growth rate from the actual return data the geometric mean is the monthly average return that, if applied each

period, would produce a final dollar equivalent to the actual final investment value. The geometric return is the best tool for calculating an expected return over a long-term investment horizon.

$$\text{Geometric Return} = \{\prod_{i=1}^{N}(1 + R_i)\}^{\frac{1}{N}} - 1$$

where N = number of periods, and R_i is the return for period *i.*

Maximum Drawdown: Measures the loss in any losing period during a fund's investment record. It is defined as the percent retrenchment from a fund's peak value to the fund's valley value. The drawdown is in effect from the time the fund's retrenchment begins until a new fund high is reached. The maximum drawdown encompasses both the period from the fund's peak to the fund's valley (length), and the time from the fund's valley to a new fund high (recovery). It measures the largest percentage drawdown that has occurred in any fund's data record.

$$\text{Maximum Drawdown} = max\ \frac{(NAV_i)}{(NAV_j)}$$

where NAV_i and NAV_j are the net asset values at time i and j, respectively, and j > i.

B. Relative Measures

The Up Capture Ratio measures the fund's compound return when the fund's benchmark return increased, divided by the benchmark's compound return when the benchmark return increased. The higher the value, the better.

$$\text{Up Capture Ratio} = \frac{E(R|R_M > 0)}{E(R_M|R_M > 0)}$$

where R is the return of the fund and R_M is the return of the market.

The Down Capture Ratio measures the fund's compound return when the benchmark was down divided by the benchmark's compound return when the benchmark was down. The smaller the value, the better.

$$\text{Down Capture Ratio} = \frac{E(R|R_M < 0)}{E(R_M|R_M < 0)}$$

where R is the return of the fund and R_M is the return of the market.

Portfolio Theory

In 1952, Harry Markowitz published an article titled "Portfolio Selection" that would spawn countless developments in finance, financial mathematics, portfolio management, and much more. The article, published in the *Journal of Finance*, outlined the roots of modern portfolio theory.[8] The primary finding in his paper was a quantifiable method that connected portfolio risk and portfolio return.

The theory is based on maximizing a specific utility function meant to model an investor's terminal wealth. Return is defined by the expected return and risk is defined as the standard deviation of the wealth, or its volatility. For a risk-averse investor, the theory offers a solution to identify the highest reward for the least amount of risk at target return levels. These portfolios are said to be mean-variance efficient. One of the key differences in Markowitz's work as compared to previous studies was the focus on overall portfolios.

[8] Markowitz, H., "Portfolio Selection", *Journal of Finance*, March 1952. pp. 77-91.

Prior to this paper, many researchers focused on individual securities or asset classes and researched concepts of efficient markets. Markowitz was less interested in efficient markets – instead, he focused on efficient portfolios.

The formulation of Markowitz's model is built on some key assumptions:

1. Individuals construct their wealth in order to maximize the expected utility of their terminal wealth.
2. Asset returns are jointly normally distributed random variables.
3. Correlations between assets are fixed and constant and forever.
4. All investors are rational and risk-averse.
5. All investors have access to the same information at the same time.
6. Risk/volatility of an asset is known in advance and is constant.
7. All securities can be divided into parcels of any size.
8. Any investor can lend or borrow an unlimited amount at the risk-free rate of interest.

Since a portfolio is a linear combination of assets, its expected return and variance are expressed as a function of all the underlying assets, represented by the following:

$$E(R_P) = \sum_{i=1}^{n} x_i E(R_i)$$

$$var(R_P) = \sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j cov(R_i, R_j)$$

where x_i denotes the proportion of asset *i* held in the portfolio; $E(R_i)$ denotes the expected return of asset *I*; and $cov(R_i, R_j)$ denotes the covariance between asset *i* and *j*.

In its simplest form, to find an efficient portfolio, the model calls for minimizing the variance of the portfolio by setting a target return and the sum of the weighting of assets to one. While there are many more constraints that can be introduced and explored, this finding was the fundamental piece that revolutionized the industry of finance. For any given return, this relationship could find the efficient portfolio. The curve demonstrated by all the efficient portfolios for a given return target is called the *efficient frontier.*

One interesting result, demonstrated by Black's Theorem,[9] shows that all points on the efficient frontier can be replicated by any combination of two distinct portfolios that are on the efficient frontier. This finding, known as a separation theorem, demonstrates that portfolio construction can be done in two successive stages. First, money managers can construct two distinct portfolios on the efficient frontier. Then, they can combine them in any way to reach return targets for investors seeking to maximize terminal wealth. [10] One direct influence of this finding is the proliferation of portfolios with just stocks and bonds and reduced exposure to alternative strategies. The next section explores how this theory was extended to build simple and usable models for investors to quantify the risk and

[9] Black, F., "Capital Market Equilibrium with Restricted Borrowing", *Journal of Business,* vol. 45, 1972, pp. 444-454.

[10] Amenc, Noël, and Véronique Le Sourd. Portfolio Theory and Performance Analysis. Chichester, England: Wiley, 2003. Print.

reward on specific assets, including a groundbreaking paper by William Sharpe in 1953 titled "A Simplified Model for Portfolio Analysis." [11]

Empirical Market and Capital Asset Pricing Models

A. The Empirical Market Model

In his research, Sharpe presented a simplification of Markowitz's model by presenting the empirical market model, also known as Sharpe's single-index model. While it has no theoretical basis, the model is used for testing the CAPM empirically by estimating the beta empirically. The model was formulated as follows:

The variance in asset returns have a linear dependency on factors that are common to the whole market as well as factors that are unique to each asset. The factors that are common to the whole market can be represented by a market index. The empirical market model is therefore written as follows:

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \epsilon_{it}$$

where R_{it} denotes the return on asset *i*, R_{Mt} denotes the return on the market index, ϵ_{it} denotes the specific return on asset *i*, and α_i, β_i are the coefficients to be determined.

[11] Sharpe, W.F., "A Simplified Model for Portfolio Analysis", *Management Science*, January 1963, pp. 277-293.

The coefficients of the line α_i and β_i are obtained by linear regression of the market returns on the asset returns for the same period, using an ordinary least squares methodology. β_i is given by:

$$\beta_i = \frac{cov(R_{it}, R_{Mt})}{R_{Mt}}$$

As a result of this model definition, the residual terms ϵ_{it} are non-correlated with market return. The total risk of an asset can then be broken down into market risk and non-market risk:

$$var(R_{it}) = {\beta_i}^2 var(R_{Mt}) + var(\epsilon_{it})^{12}$$

While Markowitz developed the computationally intensive portfolio theory, Sharpe developed a much simpler model that rendered it more operational. The next step was for Sharpe to study the influence of his findings on asset prices, which resulted in the Capital Asset Pricing Model (CAPM). The CAPM, in turn, introduced the theory of asset valuation, intimately tying risk and return.

B. The Capital Asset Pricing Model

Below are the assumptions of the CAPM:

1. Investors are risk averse and seek to maximize the expected utility of their wealth at the end of the period.

[12] Amenc, Noël, and Véronique Le Sourd. Portfolio Theory and Performance Analysis. Chichester, England: Wiley, 2003. Print.

2. When choosing their portfolios, investors only consider the first two moments of return distribution: the expected return and variance.
3. Investors only consider one investment period and that period is the same for all investors.
4. Investors have a limitless capacity to borrow and lend at the risk-free rate.
5. Information is accessible cost-free and is available simultaneously to all investors. All investors therefore have the same forecast return, variance and covariance expectations for all assets.
6. Markets are perfect: there are no taxes and no transaction costs. All assets are traded and infinitely divisible.[13]

The CAPM is characterized by the following relationship:

$$E(R_i) = R_f + \frac{(E(R_M) - R_f)}{\sigma_M^2}\sigma_{iM}$$

Where E(Ri) is the expected return of asset i, R_f is the risk free rate, E(RM) is the expected return of the market, σ_M denotes the variance of the market portfolio, and σ_{iM} denotes the covariance between asset i and the market portfolio.

The line that is thereby defined is called the *Security Market Line*. At equilibrium, all assets are located on this line. This fundamental relationship states that at equilibrium, every asset's expected return is a composite of the rate of return on the risk free asset and an asset-specific risk premium. This risk premium can be calculated by multiplying the

[13] Jensen, M.C. "Capital Markets: Theory and Evidence", *The Bell Journal of Economics and Management Science,* vol 3, no. 2, autumn 1972a.

price of risk by the quantity of risk. The price of risk is simply the difference between the expected rate of return on the asset and the risk free rate. The quantity of risk, which is called beta, is defined by the following:

$$\beta_i = \frac{\sigma_{iM}}{\sigma_M^2}$$

The beta is equal to the covariance between the return on asset i, and the return on the market portfolio divided by the variance of the market portfolio. As you can see, this beta matches up with the definition of beta used in the empirical market model earlier[14]

This pricing model provides a framework for understanding asset values by breaking down how to evaluate expected returns with expected risk. In addition, it breaks down the total risk of a security into two components: systematic and unsystematic risk. In addition, this model provides a framework for evaluating attractiveness of different assets by assessing the differences between the asset prices and the equilibrium price, located on the security market line, a massive step forward for analyzing investment opportunities and investment performance. [15]

C. Limitations of the CAPM

Any equilibrium model for the financial markets assumes some form of market efficiency. The first definition, given by Eugene Fama, states that markets are efficient

[14] Amenc, Noël, and Véronique Le Sourd. Portfolio Theory and Performance Analysis. Chichester, England: Wiley, 2003. Print.

[15] A complete derivation of the CAPM can be found in Briys and Viala (1995).

and the prices of assets immediately reflect all available information. [16] The assumptions needed for the CAPM theory to hold true includes a strong assumptions about market efficiency. In 1972, Black's Zero-Beta Model[17] demonstrated that the CAPM could exist even without including previous assumptions regarding the risk free rate. MJ Brennan[18] introduced a version that took taxes into account. Robert Merton presented a model that operated in continuous time rather than at discrete moments in time. Countless other versions of the CAPM were developed over time to adjust for perceived weaknesses in the model. Others criticized the validity of the CAPM's application to real life. In one notable case, Richard Roll demonstrated that it was impossible to include all risky assets in the security market line. Because the CAPM assumed that all risky assets were included in its mean-variance optimization, Roll stated that the theory could never be empirically proven. [19] While it didn't disprove the CAPM, it did challenge the idea that it fully captured the opportunity set available to investors.

In modern hedge funds, it is interesting to note that many hedge fund investment strategies are designed to exploit situations that are contrary to each of the assumptions necessary for the CAPM to hold true. For example, many investors do not have the resources to enhance their portfolios with colocation technology to provide an edge in finding out market information before all other market participants. This is common in

[16] Fama, E., "Efficient Capital Markets: A Review of Theory and Empirical Work", *Journal of Finance*, vol. 25, no. 2, March 1970, pp. 383-417.
[17] Black, F., "Capital Markets Equilibrium with Restricted Borrowing", *Journal of Business*, no. 45, July 1972, pp. 444-445.
[18] Brennan, M. "Taxes, Market Valuation and Corporate Financial Policy", *National Tax Journal,* no. 25, 1970, pp. 417-427.
[19] Roll, R. "A Critique of the Asset Pricing Theory's Tests", *Journal of Financial Economics*, March 1977, pp. 129-176.

high-frequency trading strategies. Another classic example is that different market participants are influenced by things other than expected return and variance. Often times, liquidity needs influence investment behavior in a way that can generate systematic returns for the liquidity provider.

Application of Pricing Models to Performance Measurement

The CAPM provides a method for assessing returns relative to risk, or risk-adjusted returns. Below are a selection of measures that are often used to assess the performance of hedge fund manager.

Alpha measures the fund's value added relative to a benchmark. Alpha simply represents the non-systemic return generated by an asset. The larger an investment or fund manager's ability to generate alpha, the more attractive it is to an allocator in the hedge fund world. Alpha generation is typically the single most important quantitative consideration and sought after quality when allocating to hedge fund managers.

$$\text{Alpha} = \alpha = \text{R} - \beta(R_M)$$

The Treynor ratio was introduced in 1965 and measures the relationship between the performance of a portfolio above the risk-free rate and its systemic risk. [20] The ratio is derived directly from the CAPM. It is designed to evaluate whether a portfolio of assets

[20] Treynor, J.L., "Toward a Theory of Market Value of Risky Assets", *Working Paper*, 1961, published in *Asset Pricing and Portfolio Performance – Models, Strategy and Performance Metrics*, Robert A. Korajczyk, ed., Risk books, 1999.

related to a certain reference benchmark is sufficiently rewarding the investor. The return (numerator) is defined as the incremental average return of a fund over the risk-free rate. The risk (denominator) is defined as a fund's beta relative to a benchmark. This measure is used quite often when very large allocators group together potential hedge fund investment opportunities by various stratifications. For example, if an allocator is evaluating multiple emerging market funds, s/he would compare their Treynor measures to see which one is generating the most desirable performance relative to an emerging market index. The larger the ratio, the better.

$$\text{Treynor Ratio} = T_P = \frac{E(R_P) - R_f}{\beta_P}$$

One of the weaknesses of the Treynor ratio was that it only made sense to use it on subsets of portfolios relative to comparable benchmarks. The results of the measurement are heavily influenced by the reference benchmark selection, which has been frequently criticized. So, the following year, Sharpe introduced a measure to eliminate that problem.

The reward-to-variability ratio, as Sharpe called it in his 1966 publication, measures the excess return, or risk premium relative to the risk free rate and the total risk in the portfolio.[21] More commonly known as the Sharpe ratio, investment manager can be assessed quickly relative to the Sharpe ratio of the market. While it holds close relationship with the CAPM, it is derived from portfolio theory and is not subject to much of the criticism of the CAPM and its directly derived measures.

[21] Sharpe, W.F. "Mutual Fund Performance", *Journal of Business*, January 1966, pp. 119-138.

$$\text{Sharpe Ratio} = S_P = \frac{E(R_P) - R_f}{\sigma(R_P)}$$

One of the advantages of the Sharpe ratio is that because it is based on total risk in a portfolio, it also accounts for non-systemic risk in an asset or taken by a hedge fund manager. Because of the robust nature of this measure, there are many meaningful variations in use today.[22] The return is defined as the fund's incremental average return over the risk-free rate. The risk is defined as the standard deviation of the fund's returns.

The Jensen measure, introduced in 1968, is derived directly from the CAPM, and is subject to much of the same criticism as the Treynor ratio. [23] However, it provides useful results to many allocators and is commonly used to evaluate hedge funds today. The measure explores whether a portfolio that is generating alpha is skill or luck. The measure conducts the following regression:

$$R_{Pt} - R_{Ft} = \alpha_P + \beta_P(R_{Mt} - R_{Ft}) + \epsilon_{Pt}$$

To evaluate whether the alpha generation is skill or luck, one calculates the t-statistic of the regression, which represents the estimated value of the alpha divided by its standard deviation. Assuming the alpha values are normally distributed, if the t-statistic is greater

[22] Sharpe, W.F. "The Sharpe Ratio", *Journal of Portfolio Management*, fall 1994.
[23] Jensen, M.C. "The Performance of Mutual Funds in the Period 1945-1964", *Journal of Finance,* vol. 43, May 1968, pp. 389-419.

than 2, it indicates that the probability of having obtained the result through luck, and not through skill, is less than 5%.[24]

Practitioners Beware: Shortcomings of Quantitative Metrics

In practice, countless evaluators stumble in their diligence by not recognizing some of the shortcomings of quantitative metrics. In many cases, the operating history of a hedge fund may not be long enough to generate statistically significant information. In others, the risk-taking behaviors of a hedge fund may have changed drastically during its tenure, rendering parts of the track record irrelevant for consideration in determining expected returns going forward.

One of the most devious missteps is when hedge fund managers do not report their performance numbers and /or risk exposures in a consistent manner relative to the broader hedge fund industry. In many ways, this was a large contributor to the 2008 financial crisis. Many hedge funds and institutional investors were generating consistent, positive returns by selling insurance contracts on collateralized debt obligations (CDOs). Based on the numbers, selling insurance on CDOs was a strategy that generated significant absolute returns with very low variability for years. The longer track the track record got, the more institutional investors and foundations grew comfortable with the strategy and started allocating more and more capital. However, the risk exposure was

[24] Amenc, Noël, and Véronique Le Sourd. Portfolio Theory and Performance Analysis. Chichester, England: Wiley, 2003. Print.

extremely high, and ultimately, many allocators who were sold on the numbers and had not taken the time to understand the risk they were taking had suffered massive losses. Ultimately, quantitative measures only tell a small part of the story when evaluating hedge fund investment opportunities.

Modern Standards for Quantitative Hedge Fund Performance Measurement

Because of a diversity of nefarious reporting practices, the fund management industry has slowly adopted consistent standards for performance reporting. The Global Investments Performance Standards (GIPS) standards are voluntary, ethical standards for calculation and presentation of an investment firm's performance results. The GIPS have their origin in the late 1980s, when the Association for Investment Management and Research (AIMR) first developed the Performance Presentation Standards (AIMR-PPS) for North America. In the late 1990s the GIPS committee published the standards after receiving extensive public commentary and formal endorsement from the AIMR Board of Governors. In 2006, the GIPS standards were finally approved by AIMR's successor, the CFA Institute and become a truly global standard, eliminating all country-specific versions.[25]

While traditional asset managers have been quick to pick up the standards and apply them, alternative investment managers have been much slower in adopting the standards.

[25] Detamore-Rodman, C., "A Novel Concept – Market Integrity". *CFA Magazine*, Sept-Oct 2007, pp. 24-25.

In response to the Madoff scandal discovered in 2008, the CFA also released a Guidance Statement on Alternative Investment Strategies for comment in 2011 which were subsequently adopted in 2012.[26] In addition, third-party administrators that independently verify net asset value every month have become a "must-have" in the industry.[27]

Real-life Application: The Satori Capital Approach

Satori Capital is a multi-strategy alternative investment firm founded upon the principles of conscious capitalism. Based in Texas, Satori's private equity business partners with management teams of companies with $5 million to $20 million of earnings that operate with a long-term perspective, commit to their mission or purpose, and create value for all stakeholders. Satori Alpha designs and manages customized alternative investment portfolios for family offices and institutions. At the end of Q3 2014, Satori Alpha managed approximately $250 million of assets.

As the portfolio manager and one of four investment committee members at Satori Alpha, in addition to determining allocations between different alternative investment asset classes and strategies, a key part of my role is sourcing, evaluating, and deciding whether or not to invest in hedge funds across the globe. Since I began my role in 2012, I have evaluated over 2200 hedge funds on behalf of our investor partners to try and find great investment opportunities. In that time, our firm has allocated to nine distinct hedge funds,

[26] "Guidance Statement on Alternative Investment Strategies and Structures". *CFA Institute, Oct 2012.* http://www.gipsstandards.org/standards/guidance/Documents/Comments/gs_alternative_investment_strategies_and_structures.pdf

[27] Jacobius, Arleen, "Alts managers slow to go with GIPS", *Pensions & Investments Online,* 1 August, 2013. http://www.pionline.com/article/20130801/ONLINE/130809997/alts-managers-slow-to-go-with-gips

or less than 0.5% of hedge funds evaluated. It begs the question, how does Satori filter out so many funds during our diligence process?

A. Overview of the Satori Alpha Investment Process

During our diligence process, we evaluate and score hedge fund managers in five key categories: leadership, strategy, operations, asymmetry, and sustainability. Each category has areas for review; for example, under sustainability, we evaluate a fund based on its culture, how it treats all of its stakeholders, and if the world would be a better place if it grew to be 100x larger, amongst many other topics.

Asymmetry is the most pertinent to the concepts explored so far in this paper. In Satori's definition, this comprises of returns, risk, market environment, edge, and partnership structure. For the first two, the quantitative measures introduced in this paper play a key role in filtering through opportunities.

First, our team identifies a multi-year macroeconomic theme that we think presents the opportunity to generate double-digit investment returns with low risk of permanent loss of capital. Once we are all in agreement on an attractive macroeconomic theme, we begin to source as many hedge funds that could potentially capitalize on the theme as possible. The sourcing process occurs through personal networks, placement agents, hedge fund social networks, capital introduction teams at prime brokerages and a variety of others. Once we receive information from a long list of potential managers, we run a screen by

evaluating geometric returns, simple alpha analysis and maximum drawdowns and compile a list of the top five investment opportunities. If the firm is not presenting GIPS-compliant material, our team first examines past prime broker statements or audits to confirm that the track record presented is legitimate. Those five move to a thorough inspection of alpha.

In addition to calculating how much alpha is generated relative to the appropriate benchmark every month since the firm's inception, we examine many other stratifications to see if we can identify certain patterns. For example, we review gross and net exposures to adjust beta factors on the overall portfolio and for the long and short books individually. If necessary, we break out alpha attribution by sector, market cap, geography, and in some cases, investment thesis with the purpose of trying to get a sense of how the hedge fund generates (or does not generate) alpha for its investors.

Once the alpha analysis is complete, we examine the hit ratio of the investor. We ask, "How frequently have past investments in the hedge fund generated alpha?" The goal is to understand if the firm is a "one-hit wonder" or if they have the "Midas touch" in identifying and investing in attractive opportunities.

One interesting note is that the Satori investment committee is entirely absolute return driven, yet the initial screening metrics implement some form of relative evaluation. While this may seem nonsensical, we believe it adds value by informing us if the investment opportunity that may seem initially attractive may just be a leveraged beta bet

without any real skill. The majority of funds we have screened are filtered out after we examine the batting ratio.

After our team gets a quantitative sense of how alpha is generated, it assesses the opportunity against the investment committee's acceptable investment regimes. Those three regimes include conservative, core, and opportunistic allocations, which are defined by expected return and risk measures articulated by the investment committee.

Figure 2: Satori Acceptable Investment Regimes (Satori 2014)

	Expected Annualized Return	Additional Upside (Expected +)	Mark-to-market downside range	Capital at risk of permanent loss
Conservative	10-15%	10% or less	0-15%	Less than 5%
Core	15% or greater	10% or more	0-25%	Less than 15%
Opportunistic	30% or greater	Multiple of Capital	25% or greater	15% or greater

If team members feel like there is a chance that an investment vehicle may fit one of the regimes listed above, the diligence process continues into evaluating macroeconomic factors, asset valuations, and sentiment to understand the potential beta exposure the investment opportunity may have. In addition, structural inefficiencies and process repeatability are explored to see if the fund manager will have the ability to continue to generate outsized risk-adjusted returns on behalf of investors. Every single one of our hedge fund allocations is generating returns because of a structural inefficiency that provides a repeatable and sustainable catalyst for alpha generation.

B. A Tale of Two Funds

In 2012, Satori was exploring the idea of allocation to non-agency residential mortgage-backed (subprime) bonds. Subprime mortgage-backed bonds caught our attention because of their compelling risk/reward profile, partly related to the unloved nature of the asset and the fact that banks had exited this market. Throughout our vigorous search for investment managers that fit our criteria for this asset class, we partnered with several experienced teams who were able to source bonds with double digit yields, floating-rate protection, and quality credit enhancement to protect against defaults. Interestingly, the vast majority of these bonds were backed by loans originated prior to 2008, so all of the borrowers in the mortgage pools had already made it through arguably the worst housing downturn since the Great Depression. If borrowers were going to default, we believed most would have already done so. The biggest risk to our thesis was that there would be another massive drop in US home prices similar to 2008 and our analysis led us to believe that this was very unlikely.

For the purpose of this paper, I will examine two funds that Satori has reviewed in this space – one that made it onto our platform and another that didn't. I start by first reviewing the metrics of these two funds.

Figure 3: Quantitative Metrics for Case Study and Benchmark Funds

	Regan Distressed Credit Fund, LP	RMBS Structured Products Fund, LP	Barclays Aggregate Bond Index
Annualized Return (Geometric Mean)	31.64%	11.68%	7.88%
Average Monthly Return	2.33%	0.93%	0.65%
Maximum Drawdown	N/A	-0.27%	-3.66%
Annualized Alpha	30.49%	12.42%	N/A
Treynor Ratio	80.87%	-39.07%	N/A
Sharpe Ratio	4.95	2.87	0.52
Jensen – t-statistic	8.58%	4.35%	N/A

The Regan Distressed Credit Fund, LP (Regan) and RMBS Structured Products Fund (Structured Products fund) both met our initial conservative annualized return target of greater than 10%. It is clear that Regan's return profile is much higher than the Structured Products fund in both the annualized return and average monthly return calculations. Surprisingly, Regan has never experienced a drawdown since the inception of the firm. This usually sends a yellow flag to our diligence team to thoroughly inspect the risk profile and valuation policy of the fund. In this case, everything looked good and we are able to move to the next step.

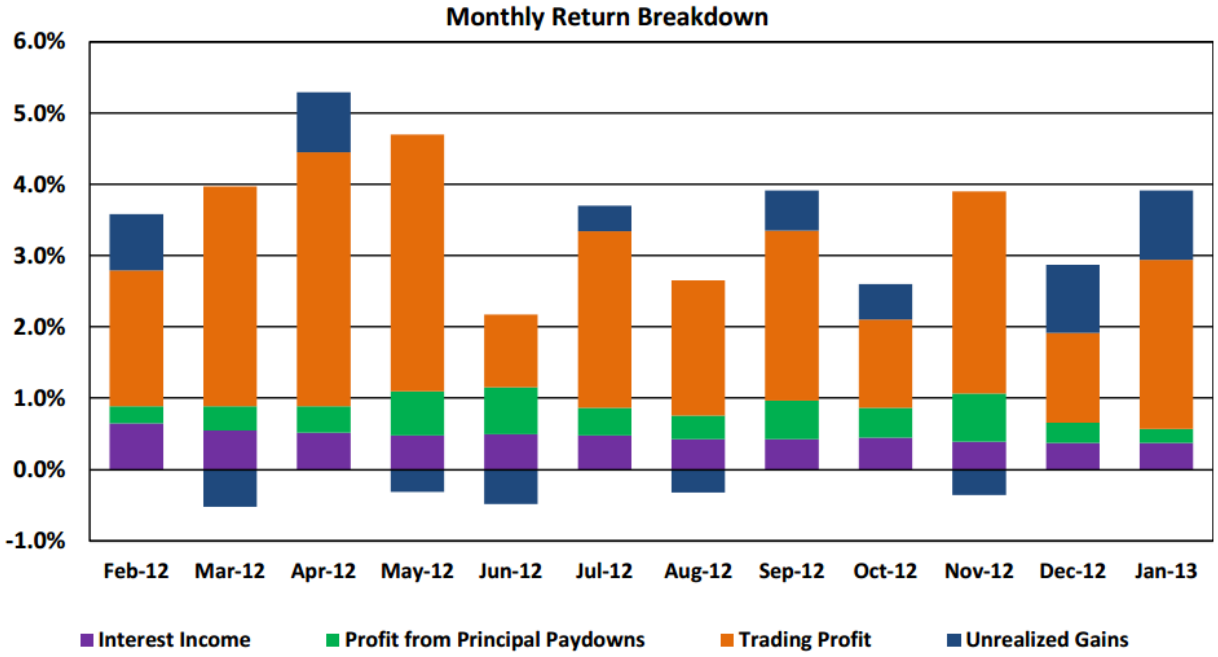
The negative Treynor ratio of the Structured Products fund indicates that it is not producing incremental return for investors over the risk-free rate relative to the benchmark used. This is a big red flag for our diligence process and would be a reason to discard the investment opportunity. Regan's Sharpe ratio indicates that it is producing almost 8x the risk-adjusted returns of the benchmark. On an absolute basis, a 4.95 Sharpe ratio is extremely high for a fund that has invested in public securities over a long period of time. Lastly, the Jensen Alpha t-statistic indicates that Regan is likely producing alpha through skill while the Structured Products Fund is generating alpha through luck.

All of this data indicates that Regan has the more desirable investment profile. The next step was to examine how Regan was consistently generating alpha in an investment strategy centered on subprime credit bonds.

Show Me the Alpha

In order to better understand how Regan was outperforming the majority of its peers, we graphed the return attribution to see if any patterns would emerge.

Figure 4: Return Attribution for Regan in from February 2012-January 2013



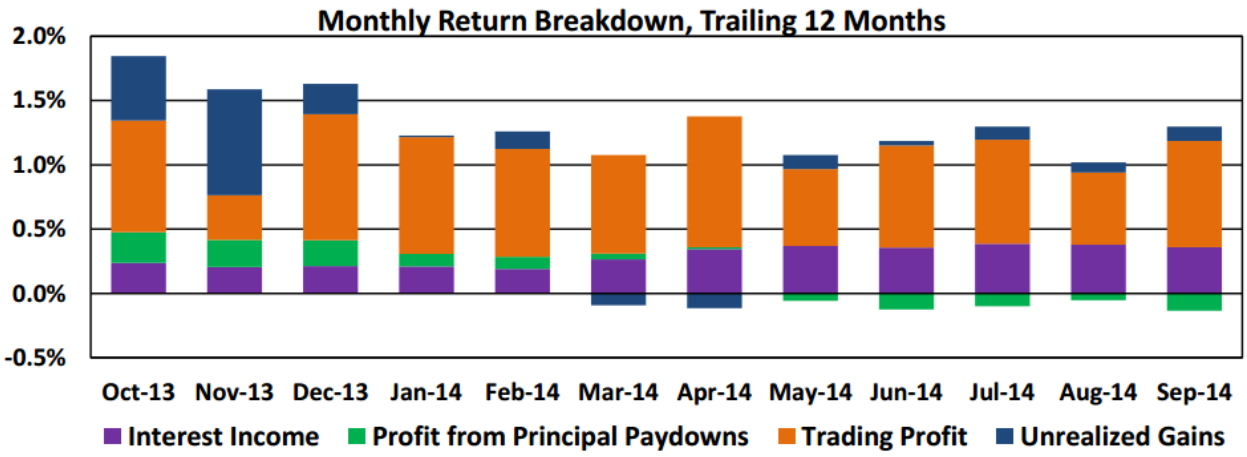
In this graph, one notices that the majority of returns are not coming from security selection, but from trading profits. As we dove deeper, we realized that the real key to Regan's success was that ever since 2008, the firms that use to trade or make markets for these securities were no longer willing or able to do so. Regan had become a liquidity provider of last resort in a market where spreads had significantly widened. In addition, the manager was doing it with no leverage, indicating a very low-risk strategy. In fact, Regan consistently sat on 20% cash to take advantage of opportunities in the market, thereby reducing its exposure to market effects. This was very unusual for the space. Many fixed income hedge funds lever up more than 5x.

The Satori Alpha investment team and committee quickly realized that Regan was an opportunity to ride the beta tailwinds of the attractive subprime space while capitalizing

on an alpha generation opportunity through active trading and market making. The combination of positive expectancies on both the beta and the alpha of the opportunity made it a very attractive investment.

After conducting thorough diligence on all the other categories, Regan was added to the Satori Alpha platform in 2012 and has grown to one of our largest positions. While the beta of the trade has tightened, Regan has consistently been able to generate outsized returns because of its sustainable edge in generating alpha. Below is the most recent version of the return attribution, which demonstrates that the trading profit continues to generate alpha for investors.

Figure 5: Return Attribution for Regan from October 2013-September 2014



Conclusion

Manager selection in hedge fund investing is the main driver of performance for investment portfolios. As hedge funds continue to proliferate and attract more and more

assets, quantitative measures can enhance any investor's diligence process. With an estimated 10,000 hedge funds in existence at any given time, having a scalable solution to quantitatively evaluate new hedge fund investment opportunities can create significant bandwidth for an allocator to focus on the qualitative elements that are typically more time-consuming in the diligence process. Further, as the GIPS standards become more pervasive, it creates an easier playing ground for allocators across the globe to assess hedge fund performance on equal footing.

Works Cited

Amenc, Noël, and Véronique Le Sourd. *Portfolio Theory and Performance Analysis*. Chichester, England: Wiley, 2003. Print.

Black, F., "Capital Markets Equilibrium with Restricted Borrowing", Journal of Business, no. 45, July 1972, pp. 444-445.

Brennan, M. "Taxes, Market Valuation and Corporate Financial Policy", National Tax Journal, no. 25, 1970, pp. 417-427.

Citi Investor Services: Business Advisory, "The Rise of Liquid Alternatives". Presentation to CAIA in Chicago. May 21st 2014.

Detamore-Rodman, C., "A Novel Concept – Market Integrity". CFA Magazine, Sept-Oct 2007, pp. 24-25.

Fama, E., "Efficient Capital Markets: A Review of Theory and Empirical Work", Journal of Finance, vol. 25, no. 2, March 1970, pp. 383-417.

"Guidance Statement on Alternative Investment Strategies and Structures". CFA Institute, Oct 2012.http://www.gipsstandards.org/standards/guidance/Documents/Comments/gs_alternative_investment_strategies_and_structures.pdf

"Hedge Fund Industry Assets Under Management." *Hedge Fund Industry Assets Under Management*. BarclayHedge, n.d. Web. 15 Aug. 2014. <http://www.barclayhedge.com/research/indices/ghs/mum/HF_Money_Under_Management.html>.

Jacobius, Arleen, "Alts managers slow to go with GIPS", Pensions & Investments Online, 1 August, 2013.

http://www.pionline.com/article/20130801/ONLINE/130809997/alts-managers-slow-to-go-with-gips

Jensen, M.C. “Capital Markets: Theory and Evidence”, The Bell Journal of Economics and Management Science, vol 3, no. 2, autumn 1972a.

Jensen, M.C. “The Performance of Mutual Funds in the Period 1945-1964”, Journal of Finance, vol. 43, May 1968, pp. 389-419.

Lowenstein, Roger. *When Genius Failed: The Rise and Fall of Long-Term Capital Management*. New York: Random House, 2000. Print.

Markowitz, H., “Portfolio Selection”, Journal of Finance, March 1952. pp. 77-91.

Roll, R. “A Critique of the Asset Pricing Theory’s Tests”, Journal of Financial Economics, March 1977, pp. 129-176.

Sharpe, W.F., “A Simplified Model for Portfolio Analysis”, Management Science, January 1963, pp. 277-293.

Sharpe, W.F. “Mutual Fund Performance”, Journal of Business, January 1966, pp. 119-138.

Sharpe, W.F. “The Sharpe Ratio”, Journal of Portfolio Management, fall 1994.

Treynor, J.L., “Toward a Theory of Market Value of Risky Assets”, Working Paper, 1961, published in Asset Pricing and Portfolio Performance – Models, Strategy and Performance Metrics, Robert A. Korajczyk, ed., Risk books, 1999.

Stefanini, Filippo. *Investment Strategies of Hedge Funds*. Chichester, England: Wiley, 2006. Print.

Wilson, Pete, and Jason Malinowski. *Hedge Fund Breakthrough*. Publication no. July 2012. N.p.: Blackrock, 2012. Print.

Curriculum Vita

Darsh Singh

2700 Canton St, Apt 104 darsh@satoricapital.com

Dallas, Texas 75226 817.200.7807

Education

Johns Hopkins University, Baltimore, Maryland

Master of Science – Applied Mathematics (Expected 2014)

Trinity University, San Antonio, Texas

Bachelor of Science – Engineering Science (2008)

Employment and Experience

Satori Capital - Portfolio Manager **2012 –**

Responsible for sourcing, evaluating, and monitoring alternative investment opportunities on behalf of Satori's principals and partners

Paras Capital Management **2010 –**

Oversee all investments for family office and actively install best practices for asset monitoring, governance, and operations

Department of Defense **2009 – 2011**

Serve the Department of Defense and its mission in signals intelligence capacity